SatFACTS EXTENDED

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In mid-December (2008) PAS-2 (aka Intelsat 2) at 169E is scheduled to 'go into inclined orbit'; that means it will no longer be 'flown' within a 70 mile square box centred over the equator. Rather it will be allowed to 'drift' in an increasingly eccentric 'figure 8' (shape) orbit crossing over the equator approximately two times each day; once heading southeast ('downhill') and then heading northeast ('uphill'). The initial inclination is expected to be within 0.5 degrees (at the extreme north and south position above and below the equator) but over 2009 that will grow to at least +/- 1.5 degrees.

'Inclined orbit' operation will require larger dishes using this satellite to either (1) accept partial day service, or, (2) install auto-tracking equipment which functions by monitoring the signal level of the received signal and in small (tiny) increments maintains an optimum pointing direction for the receive antenna as the satellite drifts through the orbit plane. As the inclined orbit gyrations grow over time (increase in distance north and south of the equator) the smaller and smaller dishes will see the effects of the bird's daily flight pattern. Initially, dishes in the region of 5m and larger will be affected but by late in 2009 dishes as small as 2.4 metres should be experiencing part-of-day signal outages. Think of a stable in-orbit satellite which has had the dish incorrectly installed, pointed (for example) at 170.5 degrees for PAS-2 when the correct point in the sky was 169E. The 1.5 degree 'pointing error' (in this example) would quite logically produce a lower signal level from the satellite. Inclined orbit substitutes a moving satellite for an on-ground pointing error - but the net effect is the same, save the complete transit time around the 'figure 8' formation with the satellite (in theory) appearing at the correct (169.5) location approximately twice each day for a period of time that relates to the 3dB 'beamwidth' of the receiving antenna.

'Inclined Orbit' is a financial decision by the satellite operator (Intelsat hence the recently renamed Intelsat 2 designation). At some point in the lifetime of any satellite, 'station keeping fuel' (typically a hydrazine gas) which propels through small on board jets approaches 'empty'. To preserve operation for as short as a few extra months to as long as a few extra years, before the fuel is totally depleted the daily/weekly 'station keeping' exercise (which involves precision firing of hydrazine jets to maintain the satellite 'position) is 'cut back' and 'adjusted'. Maintaining a satellite within a 70 mile square imaginary 'box' above the equator requires 'X' fuel per day/week/month.year. Allowing the satellite to be 'pushed' into inclined orbit and then allowed to 'drift' in a figure 8 format requires X divided by 2 or 3 in fuel. Thus by not maintaining PAS-2 within the box for perhaps 6 months but continuing the station keeping outside the box extends the orbital lifetime to perhaps 12 or 18 months; at a price.

The 'price' of course is to the earth stations - both downlink and uplink - which must limit their satellite-use time to increasingly shorter periods each day (as the size of the figure 8 orbit grows daily making the satellite's 'time' over the original 70 square mile box shorten), or, install automatic or even manual 'satellite tracking equipment' to move the dish in unison to the figure 8

PAS-2: The Original

If one event propelled the growth of satellite services (TV, radio, data) in the Pacific region, it was the launch of PAS-2 to 169E on August 07, 1994. For the first time the entire Pacific region as well as much of southern Asia was capable of direct interconnection with the USA. The reaction from the market was robust, enthused and wide ranging. For the first time individual dishes as small as 2m on C-band actually could watch television (previously only sporadic Intelsat reception from aging satellites, often in 'inclined orbit', required dishes from 5 to 7m in size; not a 'backyard' or cost effective choice for most). Through at least the first quarter of 2011, **NO** replacement for PAS-2 is scheduled making this the true end of a pioneering era.

orbit changes. As would be expected, present users of PAS-2 will individually make their own decision as to continuing on board this satellite or moving to another. The first group to be affected will be the PAS-2 Ku band users (see list here) where even a 0.5 degree pointing 'error' created by the figure 8 inclination would be noticeable on all but the smallest of dishes. By the time the error has grown to (+ and -) 1.5 degrees orbital location change, only the smallest functional C-band dishes (i.e. 2.4m in diameter and below) will operate without tracking - but not for long as the inclination grows.

PAS-8, PanAmSat's PAS-2 companion, was launched to 166E April 11, 1998 making it 4 years 8 months newer. PAS-8 differs from PAS-2 by design and manufacture; Space Systems Loral type LS-1300. Shortly after the launch a number of user problems were reported but never admitted by either Loral or PanAmSat. The essence of the reports involved strong indications of two problems: vertical polarization coverage was significantly below expectations from approximately 174E (to the east) while horizontal polarized signals in the 4050-4200 (MHz) region worked either very poorly or not at all in the same approximate footprint region. Other PAS-8 problems have been noted but never admitted by the operator. By extrapolation, PAS-8 would enter inclined orbit (or be replaced) not later than mid-2012.

There is one additional ingredient in losing PAS-2 (and perhaps in 2012 PAS-8); NSS (New Skies Satellite which operates out of Europe). Presently NSS-5 is at 183E/177W with C and Ku coverage that includes New Zealand and Australia in various footprint formats. NSS-9 is scheduled to replace '5' with launch in mid-February (2009). NSS-5 was launched in 1997; NSS-9 will have a global pattern of 33-35 dBw over NZ and Australia and as high as 40-41 dBw on each of three hemi-beams. '5' was clearly positioned to challenge the mid-Pacific advantages offered by I701 (180E) and '9' with more power and better footprints will up the ante in this competition.

Our loss is our loss

PAS-2 provided the spark which would ignite a DTH world in the Pacific. Without it, when it happened (launched July 9, 1994; some programming tests late August 1994) C (and later Ku) DTH in the Pacific region would have been distinctly different, if at all.

The first issue of SatFACTS (September 1994) coincided with PAS-2 springing to life although 'surprise-surprise' it was not PAS-2 that captured the early spotlight. Rather it was something known as 'Rimsat' appearing without advance fanfare at 142.5E using a recently launched Russian Express bird which was the temporary headline. Also new at the same time - a suddenly refired and replaced Gorizont at 139.9 east.

As of November 1, 2008

PAS-8, flown within 'the box', was being allowed to drift between 165.9981E and 166.0248E; and between .0025 (north) and 0.00215 (south) of the equator. PAS-2 already exceeds these limits and will be allowed to go into 'controlled freefall' on or about 15 December.

Present users of PAS-2 / 166E

3845V: Al Jazeera, ART Australia (CA)
3864V: Pacific IP (data)
3901H: 'California Bouquet' including Australia Net Pacific, BBC World News, Iqraa (FTA)
3992V: Fox (CA)
4022H: Hope Channel International (FTA)
...
12.281V: Telstra including ABC1 NT, WIN, BigPond Broadband (CA)
12.401V: Airang World (FTA)
12.604V: NASA TV (CA)
...

As you can see from the above, PanAmSat/ Intelsat has significantly scaled back use of this satellite in favour of PAS-8/Intelsat 8 (166E) and Intelsat I701 (180E). The 'California Bouquet' on 3901V was perhaps the most important service from shortly after the late 1994 start of service and at various times included FTA movies, sport, general entertainment and news services as North American cable TV speculators attempted to recreate the US experience in the Pacific; alas, it was not to be.

The future is not bright

PanAmSat was by the launch of PAS-2 a struggling but frightening competitor to Intelsat. In 1991, the creative minds behind PanAmSat gambled it all ordering three Hughes HS-601 satellites; at the time the 'latest and greatest'. PAS-1, 2, and 3 were scheduled to be placed geostationary over each of the three oceanic areas defined by satellite planners; Atlantic, Indian and Pacific. As the first was to be delivered they ordered a fourth HS-601, as a 'spare'. Someone was clairvoyant because PAS-3 (Indian Ocean) was lost during launch allowing PAS-4 to complete the triple play.

Future launches do not look attractive for our region:

Intelsat 14: to 115E as replacement April-June 09

Intelsat 15: to 85.15E replacing IS-709 April-June 09

Intelsat 18: to 180E replacing IS-701 January-March 2011.

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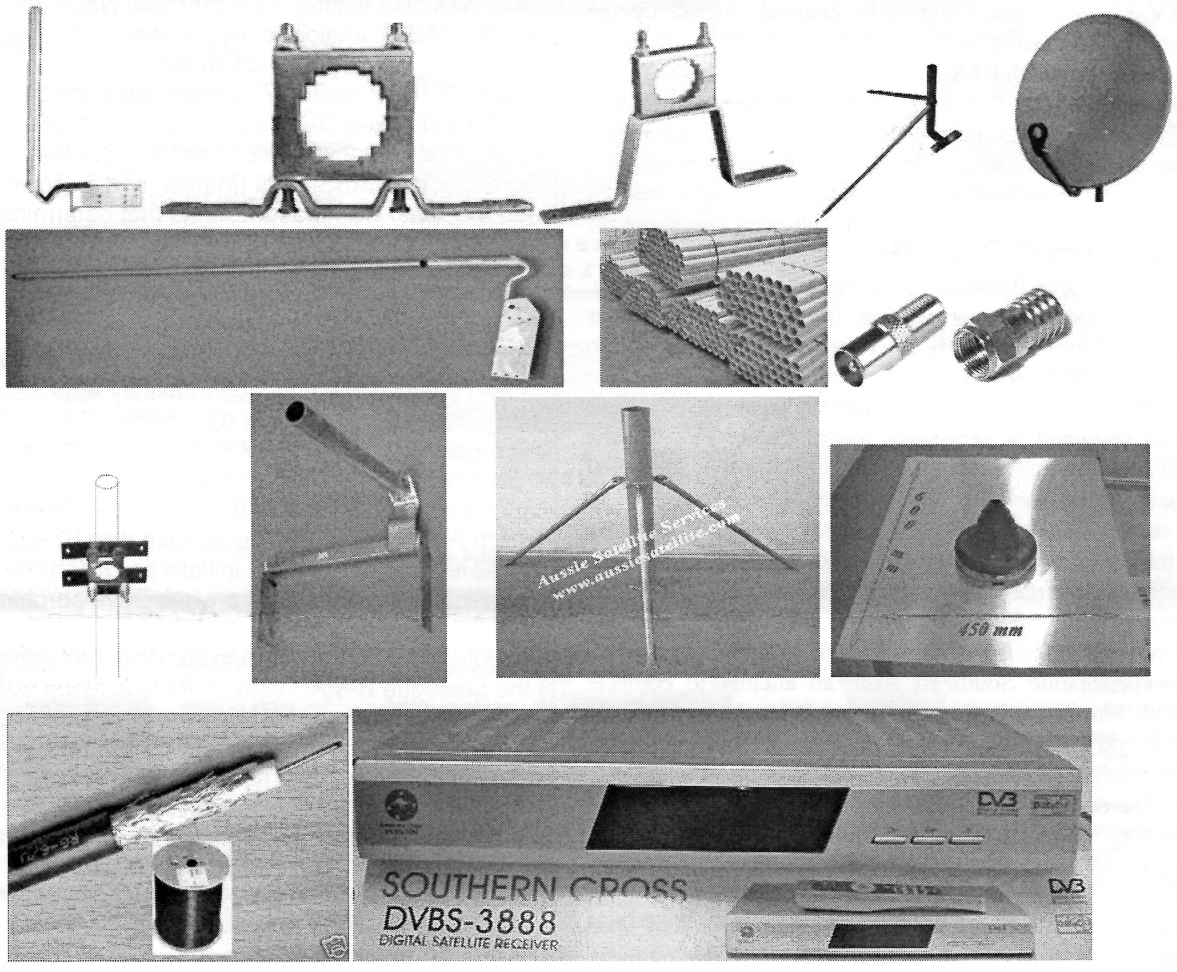

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No English television on either one but for the first time it was distant television on dishes down to around 3m in size. PAS-2 over the next 12 months would not only change all of the programming rules but by introducing the first MPEG-1.5 (later MPEG-2) digital services push the development of what we now take for granted as a delivery technology.

The 'hype' for C-band (FTA) television reached a peak during the 1996-1999 period. A SatFACTS sponsored trade association, SPACE (South Pacific), attracted upwards of 500 attendees to the University of Auckland (Tamaki) Campus in February 1996 with major corporate support from the American NBC network (then operating ANBC - Asian NBC two channels in analogue), CMT (Country Music Television which sponsored a free stage show of country music artists during the trade show), CNN and others created a totally 'positive' attitude within the suddenly growing industry.

Maser Technology Group (Auckland) saw the opportunity to promote 'traditional North American cable TV systems' throughout New Zealand, fueled by the rapidly increasing number of CA and FTA television channels through PAS-2 and other satellites. In Auckland suburbs such as Remeura NZ Telecom spent a reported $70 million plus installing a 50-550 MHz cable TV service with an initial offering of 18 channels for around NZ$35 a month. The system was closed down with 24 hour notice leaving dozens of sub-contractors out of work and with no financial recourse.

It all came down to programming. CNN, Discovery, ESPN and others originating in the US were under contract by the new SKY network service making them not available for Telecom's cable TV network. The 'signals' were easily available but the 'legal rights' to their use remained a pen-stroke away. Cable TV in New Zealand hung on by a string which within five additional years would break; Sky NZ had won the contest.

PAS-2 evolved into a 'feed-cast' service - originating links between North America and the Pacific with an annually decreasing number of full-time 24 x 7 users. Companion PAS-8, apparently 'technically defective' from day of turn-on, was intended to focus more of its footprints into Southeast Asia, an attempt to compete with AsiaSat and other (including Palapa) providers. At the end of the business day, it would be "cost" and "coverage" which determined success or failure.

The decision to not replace PAS-2, perhaps not PAS-8 either, "at this time" is as business decision. More and more of the trans-Pacific video and data traffic has moved off to undersea fibre leaving only isolated outposts (Fiji, New Caledonia, Tahiti) dependent upon delivery from geo-statationary orbit. For the moment, for television, satellite is a logical answer. But the odds are not good it will remain that way at the end of 2018.

The 'Early' PAS-2 Programmers

They came, stayed around a while (some for only days) and they disappeared but each one provided a spark of new enthusiasm, hope and intense interest that 'now, finally, satellite TV is arriving in the Pacific'. It would, but ultimately not on PAS-2.

By October 1994 SatFACTS monthly list of C and Ku band services available noted ESPN (B-Mac analogue), PRIME TV (believe it or not - a short lived Texas based FTA movie service!), CMTV (Country Music TV FTA analogue) and ABS Philippines in that strange new digital format. There was no Ku band DTH service - yet - for Australia from any bird.

By February 1995 CNNI, ANBC, NHK, Discovery, and CBS were at least part-of-day available in FTA analogue while CCTV, CTN, NTU, and ABS-CBN were in the brand new and difficult to find receivers for MPEG (called CDV in 1995). CMT was also testing via PanAmSat Napa uplink on Ku PAS-2; analogue, which some in NZ and Australia had 'found'.

March 1995 SatFACTS would introduce the Jerrold (USA) DSR1500 MPEG-1.5 digital receiver (MPEG **2** was still to arrive). Our test was arranged with ABS-CBN (Manila) and it allowed some quarter dB measurements that determined anything above 5.5 dB CNR produced full lock signals whereas the best analogue receiver was starting to show sparklies at 8.0 dB CNR. We were learning.

'Galaxy', Australia's forerunner to Ku-band pay-TV was delivering 8 channels by April 28th using General Instruments (GI/Jerrold) DSR 1500 receivers. We found all 8 in northern NZ at SatFACTS on a 2.4m dish which we reported attracting (you guessed it!) not so subtle interest from Australian folks. The service was FTA as well it could afford to be initially as DSR 1500 receivers were as rare as a white Dove perching on your 60cm dish.

By July 1995 TNT + Cartoon Network had joined the analogue B-MAC club on PAS-2, along with MTV.

The PAS-2 'advantage' would come crashing down in February 1996 as AsiaSat 2's new digital MCPC package inclusive of five FTA channels from Europe became common knowledge during the SPRSCS '96 Auckland trade show. AS2, below 5 degrees at the show, worked to a charm and offered within a year a multitude of FTA MPEG-2 services including FTA TV and radio from across Europe in the DW managed 'Euro Bouquet'. Fame and fortune were fleeting for PAS-2 and here it is 14 years later closing down!

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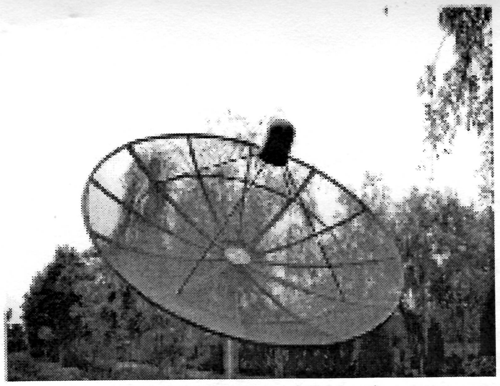

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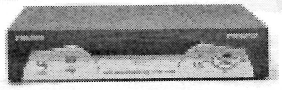

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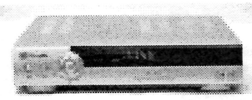

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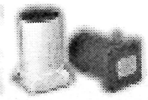

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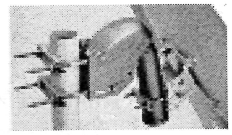

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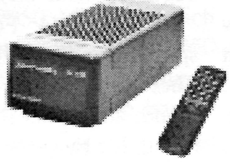

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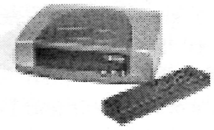

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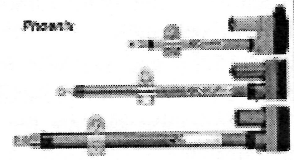

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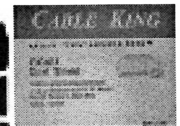

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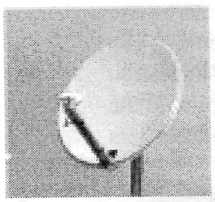

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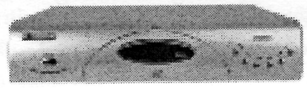

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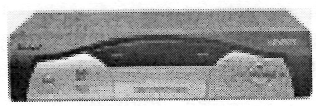

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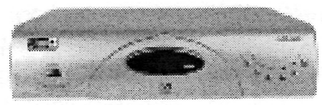

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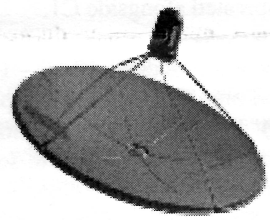

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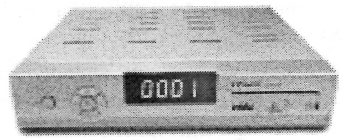

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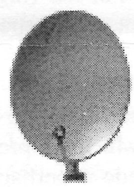

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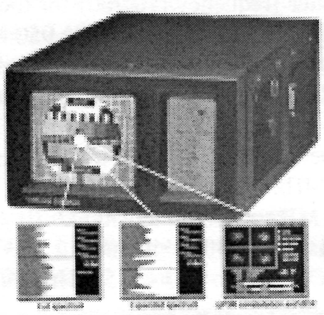

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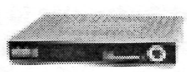

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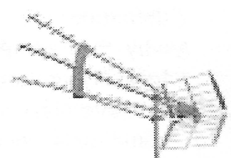

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Rumoured Launch of Optus D3

Officially, there is no formal announcement concerning the launch of Optus D3; 24 Ku band transponders at 125 watts each. Unofficially the rumours are flying.

D3 was originally intended to go where D2 now operates (152E) and D2 was to go to 156E where it would be co-flown with pre-existing one-of-a-kind C1. C1 is the workhorse satellite for Aurora, Austar and Fox and operates like all previous Australian Ku band birds in the 12.25 - 12.75 GHz region. D3's true design is cloaked in corporate 'need to know' security classifications as if somebody out there would actually 'profit' from this knowledge.

Rumour #1: D3 will be launched in April 2009, to 156E, to be operated alongside C1.

The design of D3 originally called for it to contain double sets of transponders; 12.25 - 12.75 and then the almost new-to-our region 11 GHz-plus band (setting aside Intelsat). The present actual 'compromise' design is a matter of corporate 'need-to-know' security but "24 Ku band transponders" is at least a clue.

Why 12.25-12.75 if C1 is functional? A backup should some or all of C1 fail; that was the original reasoning.

The concept of flying two (or more) satellites in more or less the same 'seventy-mile-box' as a permanent operational mode is hardly new or unique. Europe's prime satellite locations (28.2E and 19.2E) house as many as six satellites all occupying the 'same box' but using different frequencies for the downlink to earth (as low as 10.7 GHz, as high as 12.75 GHz).

Rumour #2: D3 will be used by Australia and New Zealand; individual transponders will have two different individual 'footprints' (such as D1 has) each pointed at a separate target area (as in Australia is one, New Zealand is another).

New Zealand's SKY TV Network is alleged to have some quantity of the new transponders (no - we are not guessing how many) which will be used (the rumours suggest) for expansion of HD (high definition) television channels. Some recent retail reports suggest ten percent (10%) of all New Zealand homes now have a HD 'ready' new-era TV receiver. Logic suggests these 'early innovators' already have SKY so the temptation to offer HD to TV receivers which are presently lying fallow and unused in the HD mode is perhaps unjustified, unless of course 'HD service' will be charged a premium price. And then it all makes business sense..

Australia's use of the new D3 capacity is more suspect.

Rumour #3: Foxtel intends to shift all 'commercial customers' from C1 to D3 says the rumour mill. The definition of what constitutes a 'commercial customer' or why they should be given their own satellite escapes logic. Does this mean that Fox Sports 1, 2 and 3 (for example - just an example) will be 'duplicated' on C1 (for home users) and D3 (for 'commercial' users)? And if so, why??? If this has something to do with restricting the D3 transponders to NDS only, eliminating 'piracy' which goes hand-in-hand with Austar's use of Irdeto 2, then it begins to make business sense.

Rumour #4: Foxtel's movies on demand service is spinning upwards of $150,000 a week for the service. That is the rumour, but if true it adds up to $600,000 a month additional income from people who cannot wait a month (or two) for the newer movies to end up on Movie One (et al) as a part of the regular monthly charge. The rumour goes on to explain Foxtel (and by suggestion Austar as well) has found a 'vein of consumer gold' in the pre-release movies and several of their new transponders will be dedicated to expanding the number of such movies available. Again, it is a rumour.

What is not a rumour is that once D3 is functional, SKY TV and Foxtel/Austar will immediately be incurring a new monthly operating expense; the new transponders.

The hardware

D3 and C1 will share a common boresight and therefore can share a common LNBf. But they will not share a common orbit-to-earth downlink frequency band thus requiring the LNBf to be capable of some frequency adjustment.

The LO (as in 'local oscillator') is the answer; when it operates at 11.300 GHz, a signal appearing at 12.250 ends up in the satellite receiver at 950 MHz (while a signal at 12.750 appears at 1450 MHz). The math is simple: 12.250 - 11.300 = 950 MHz.

The LO is factory set and there are several options: 9.750, 10.600, 10.650, 10.700, 10.750 and 11.300 are common. A signal appearing from the satellite at 11.400 for example will find itself inside the (L-band) satellite receiver at:

9750 LO = 1650 MHz
10600 LO = 800 MHz
10650 LO = 750 MHz
10700 LO = 700 MHz
10750 LO = 650 MHz
11300 LO = 100 MHz

Only the first of these falls inside the acceptable passband of a typical L-band (950-2150 MHz) receiver. Current Austar/Foxtel LNBf devices have twin LO frequencies of 11.300 (12.250 = 950 MHz) and 10.700. The latter frequency (10.700) for the LO obviously will not shift a 12.25 GHz signal to 950 MHz.

So where does the 10.700 LO come into play; for the new, D3, frequency band? The menu on the receiver selects which LO to use and when. The 10.700 works with the following satellite-to-earth downlink bands:

950 MHz = 11.650 downlink
1450 MHz = 12.150 downlink

whereas the 11.300 shifts the 12.25 - 12.75 GHz portion (from C1) also to 950 - 1450. Hummm. That seems a tad

dangerous with both of the IF outputs occupying the same L-band range. Let's try again.

Suppose our 11.300 was replaced with say 10.700 (LO)? Now the 12.250 (- 10.700) ends up inside the L-band receiver at 1550 MHz (to 2050 MHz). Which leaves us with something occupying the 1550-2050 region of the L-band receiver's passband but nothing in the original standard, 950-1450 MHz. And we have a new sub-12.25 GHz band to place there. The object is to be able to direct the LNBf to intercept and process C1 to some portion (say 1550-2050) of L-band and D3 quite separately to another portion of L-band (say 950-1450).

950 minus what equals a frequency lower than 12.250? The answer is 11.300 (yes, that is a familiar number). And 1450 minus what equals a frequency lower that 12.750? The answer is the same; 11.300.

So - if the Austar and Foxtel current session of LNBf devices have twin/dual LOs at 10.700 and 11.300, where do we end up in the frequency range with the new D3 satellite? The answer is not as clear-cut as you might suspect.

We have already determined, logic is the telling ingredient, that it will not be good engineering practice to convert both C1 and D3 to the same 950-1450 MHz region. One needs to go there, the other needs to 'stack' someplace higher than 1450. If we begin with 12.250 - 12.750 "in-place" from C1, that leaves us with a work-around; making D3 fit in. Logical? Not quite.

The only reason C1 ends up in the 950-1450 (MHz) range is because we have an established universe of 11.300 GHz LOs out there. At any point, we could if we wish stop providing 11.300 LOs switching say to 10.700. That would shift us from 950-1450 with 11.300 to 1550-2050 with 10.700. That is an option, and it leaves us not using the 950-1450 MHz L-band spectrum. This would make C1 the higher L-band segment user and leave the lower (950-1450) segment available for D3.

But how do we get some 500 MHz block in the 11-12 GHz region to 950-1450? The answer is in the math. Say 11.400 is either one 'end' of or within the desired new passband to be converted to L-band. 11.400 - 11300 is 100 MHz which clearly is outside the passband of a 950-2150 MHz L-band receiver. So the LO frequency must be at least 850 MHz below 11.300 to affix 11.400 to 950 MHz. That would be 10.450 (+950 = 11.400). That is doable but not a standard LO frequency. The nearest 'standard' to 10.450 is 10.600 which would place 11.400 at 11.550. Alas, the 'Austar/Foxtel standard' is 10.700 which to translate some 11 GHz frequency to 950 would be 11.650; creating a downlink band of 11.650 to 12.150 (12.150 - 10.700 = 1450 MHz). Is that our answer?

Not quite. If the 10.700 LO will downconvert 11.650 - 12.150 to 950 - 1450, it will also down convert 12.250 - 12.750 to 1550 - 2050. And if we elected to feed 12.250 - 12.750 into the 950 - 1450 L-band region using the original 11.300 LO, we have both birds covered on both bands with a LNBf that selectively uses either 10.700 (for D3) or 11.300 for C1. The L-band usage under this situation is 950-1450 and 1550-2050, but (typically) only one at a time into a single RG6 feedline. Variations of this could feed both simultaneously into one RG6 line, or both simultaneously into two feedlines (the selection between feedlines being made at the receiver proper). The options are obviously many which helps to explain the tremendous selection of LNBf devices with widely varying functional characteristics relating to the input frequency band(s) and the way the output(s) are configured for transmission on to the awaiting receiver(s).

It is the (s) in receiver which creates the most serious challenge. In a one TV set household, only one LO needs to function at a time; the receiver selects which one to fire and when, based upon the viewer selection between C1 and D3. But when there are two (or more) receivers each of which is allowed independent access to either C1 or D3, all of the rules change. Now there will be times when two (or more) receivers are tuned to C1, or D3, or at least one receiver to each of the two satellites. And the LNBf is expected to keep all of these 'commands' functioning.

Logic says that if we are combining 950 - 1450 (C1) and 1550 - 2050 (D3) into a single (RG6) feedline, the receiver need only change LO frequency to select which of the two 'blocks' will appear within the menu channels. But if there are two feedlines, each one dedicated to either 950 - 1450 or 1550 - 2050, each receiver must now not only switch LO but also select between two feedlines. That would require some type of switching network at each receiver (DiSEqC or other). This pretty much collapses the logic concerning selecting two feedlines for two satellites feeding two or more receivers.

Multiple options

The most obvious answer to the many choices is 'simplistic'; what solution requires the least expensive parts, offers the highest rate of installer success with a minimum of new technology, and uses readily available hardware (the 'why re-invent the wheel?' logic).

The choices with 11.300 and 10.700 LOs are C1 to 950-1450 or C1 to 1550-2050; but D3 can only go to 950-1450 and only if D3 operates in the 11.65 - 12.15 band (11.65 - 10.700 = 950; 12.15-10.700 = 1450).

The 'buffer zone' between 1450 (top end of D3) and 1550 (bottom end of C1) is 100 MHz - a requirement to eliminate possible L-band LNBf degradation should (for whatever reason) either C1 or D3 be significantly stronger (or weaker) than the other at any given receiving location. Which brings us to the bottom line; can Optus fly these two birds, in the same box, and equalize the footprint levels at all receiver locations? Time will tell.

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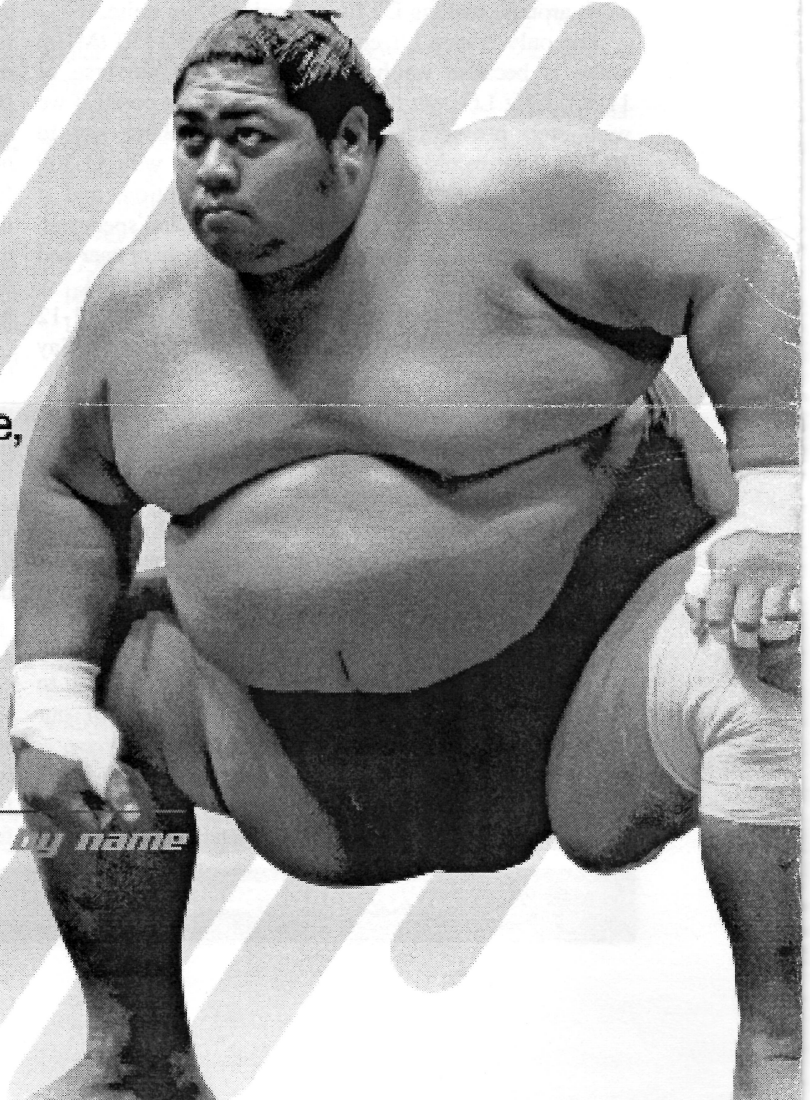

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